

Claims

- [c1] 1. A method of manufacturing a semiconductor device, comprising the steps of:
forming a first insulating layer over a semiconductor substrate;
forming a first conductive layer, an oxide dielectric layer, and a second conductive layer over the first insulating layer;
forming a capacitor, which consists of an upper electrode made of the second conductive layer, a dielectric layer made of the oxide dielectric layer, and a lower electrode made of the first conductive layer, by patterning the second conductive layer, the oxide dielectric layer, and the first conductive layer;
forming a second insulating layer over the capacitor and the first insulating layer;
forming a hole in the second insulating layer over the upper electrode; and
supplying an activated oxygen to the capacitor via the hole in a state that the semiconductor substrate is heated.
- [c2] 2. A method of manufacturing a semiconductor device,

according to claim 1, wherein the oxygen is activated by irradiating any one of ultraviolet rays and a microwave.

[c3] 3. A method of manufacturing a semiconductor device, according to claim 2, wherein heating of the semiconductor substrate is executed not only by any one of the ultraviolet rays and the microwave but also by a heater.

[c4] 4. A method of manufacturing a semiconductor device, according to claim 3, wherein the heater is at least any one of an infrared lamp arranged over the semiconductor substrate and a heater arranged below the semiconductor substrate.

[c5] 5. A method of manufacturing a semiconductor device, according to claim 2, wherein the oxygen that is activated by irradiating the ultraviolet rays is oxygen radical.

[c6] 6. A method of manufacturing a semiconductor device, according to claim 1, wherein a temperature applied to heat the semiconductor substrate when the oxygen is supplied to the capacitor is set in a range of 300 to 450 °C.

[c7] 7. A method of manufacturing a semiconductor device, according to claim 2, wherein the ultraviolet rays are irradiated from an excimer UV lamp that has a wavelength peak at 172.5 nm.

- [c8] 8. A method of manufacturing a semiconductor device, according to claim 2, wherein the ultraviolet rays are irradiated from a ultraviolet lamp that has wavelength peaks of at 187.5 nm and 225.0 nm.
- [c9] 9. A method of manufacturing a semiconductor device, according to claim 2, wherein the microwave is irradiated from a conductive coil that is connected to a microwave power supply.
- [c10] 10. A method of manufacturing a semiconductor device, according to claim 2, wherein the oxygen is introduced into a low-pressure atmosphere in which the semiconductor substrate, and then the microwave is irradiated to the oxygen.
- [c11] 11. A method of manufacturing a semiconductor device, according to claim 1, wherein the oxygen is introduced into a space over the second insulating layer together with an inert gas.
- [c12] 12. A method of manufacturing a semiconductor device, according to claim 1, wherein the second conductive layer is made of at least one of iridium and iridium oxide.
- [c13] 13. A method of manufacturing a semiconductor device,

according to claim 1, wherein the oxide dielectric layer is a ferroelectric layer.

[c14] 14. A method of manufacturing a semiconductor device, according to claim 1, further comprising the step of forming an upper electrode leading wiring, which is connected electrically to the upper electrode via the hole, on the second insulating layer after the oxygen is supplied to the capacitor.

[c15] 15. A method of manufacturing a semiconductor device, according to claim 1, further comprising the steps of: forming a contact hole on an upper surface of the lower electrode in an area, which protrudes from the upper electrode, by patterning the second insulating layer; and forming a lower electrode leading wiring, which is connected electrically to the lower electrode via the contact hole, on the second insulating layer.

[c16] 16. A method of manufacturing a semiconductor device, according to claim 15, further comprising the step of forming a conductive plug in the contact hole.

[c17] 17. A method of manufacturing a semiconductor device, according to claim 1, further comprising the step of forming a conductive plug, which is connected to a lower surface of the lower electrode, before the first conduc-

tive layer is formed on the first insulating layer.